SOIL ORGANIC CARBON SEQUESTRATION SIMULATED BY EPIC IN COTTON ROTATIONS FROM THREE MAJOR LAND RESOURCE AREAS IN THE SOUTHEASTERN USA

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SUMMARY

Carbon sequestration in soil has emerged as a technology with significant potential for stabilizing atmospheric concentrations of greenhouse gases at non-threatening levels (Izaurralde et al., 2001). Estimates of long-term soil organic carbon (SOC) storage in agricultural cropping systems are needed to evaluate the effectiveness of different management systems across a wide range of soils, crop, and climate conditions (Causarano, et al., 2005). However, the amount of SOC sequestered in a field or region is costly to measure and monitor. In addition, protocols are still being developed, making it difficult to base policies directly on environmental performance (Feng et al., 2004). There are relatively few long-term studies addressing SOC sequestration, and therefore, simulation modeling should be considered to estimate the effects of management on various soil properties under a wide range of conditions (Williams, et al., 1984).

The USDA–Natural Resource Conservation Service (NRCS) uses the Soil Conditioning Index (SCI) to predict changes in SOC with different agricultural management practices. The SCI is used to calculate payments to landowners enrolled in the USDA-NRCS Conservation Security Program (CSP) (Causarano, et al., 2005). The Erosion Productivity Impact Calculator model (EPIC) (Williams et al., 1984) was recently updated to include a new C and N transformation submodel, based on concepts and some equations from the CENTURY model (Izaurralde et al., 2006).

The objectives of our study were to (1) simulate the long-term effects of different agricultural management practices on SOC, crop yield, and water-use efficiency in three Major Land Resource Areas (MLRA) in the southeastern USA using the revised EPIC model (v. 3060) and (2) compare predictions of SOC change using EPIC and SCI. The treatments represented a hierarchy of management practices that were expected to increase biomass input to the soil and minimize soil disturbance.

Significant changes in SOC during 50-year simulations for the Texas Blackland Prairies region occurred, in which SOC declined by 6 Mg ha^{-1} under monoculture cotton with conventional tillage and increased by 30 Mg ha^{-1} under cotton/winter cover crop with no tillage. As more residues were added to the soil using a corn–cotton rotation with cover crops under no tillage, simulated SOC increased. The SCI for each of the three MLRAs and four management systems

produced similar results; the SCI suggested that SOC would increase at a greater magnitude under no tillage compared with conventional tillage at all locations. Contrasting with the SCI, EPIC simulations did not suggest a difference in SOC between conventional and no tillage in the Coastal Plain and Southern Piedmont regions.

The revised EPIC model may need to be calibrated with field data from southeastern USA soil and climate regimes and further tested before reliable estimates of SOC can be made. Several field studies in the southeastern USA have shown the benefits of reduced tillage and crop rotations on sequestering SOC. Calibration of the revised EPIC model under different boundary conditions for soils and climates other than those previously tested will help determine and verify whether the model can satisfactorily simulate SOC sequestration throughout the southeastern USA. Efforts are currently underway to test the EPIC-CENTURY model as a decision-making tool for C management from remotely-sensed images of residue management and tillage practices from the midwestern USA (NASA, 2005). A similar effort would be useful to verify that the revised EPIC model can accurately simulate long-term changes in SOC throughout the southeastern USA.

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